

National Aeronautics and Space Administration

FINAL TECHNICAL REPORT FOR NAG 5-1954

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Final Technical Report for NASA ROSAT grant NAG 5-1954

Below follows the requisite final technical report on grant NAG 5-1954, which was awarded under the NASA ROSAT Guest Investigator Program to Columbia University (PI's Jacqueline van Gorkom and Tom Hamilton) This grant was awarded for a number of projects on two rather different topics.

1. "*An X-ray Survey of Compact Groups of Galaxies.*" We have received data for 4 groups so far, which were scheduled as contingency observations during AO's 2 and 3. This project is a collaboration of J.H. van Gorkom, T.H. Hamilton, P.M. McMahon and B.A. Williams.
2. "*The Fate of Gas in Merging Galaxies.*" For this project data were received for 2 systems so far, which were scheduled during AO 3. This is a collaboration of J.H. van Gorkom, J.E. Hibbard and F. Schweizer.

1. An X ray survey of Compact Groups of Galaxies

It has been proposed to image the X-ray emission from 10 compact groups of galaxies, which span a range in compactness and which all have already been imaged in neutral hydrogen with the VLA. If compact groups are in the process of merging, we expect the smaller ones to be nearer their coalescence. PSPC observations of groups can verify this scenario, and elucidate some of the still poorly understood details of the process. We have received PSPC data for 4 groups, observations of the remaining six groups are scheduled to be performed during AO-4.

The results are:

HCG	z	optical linear size kpc	c/s	X ray morphology
79	.015	17	0.013	resolved
44	.020	72	0.020	extended
31	.013	11	<0.01	
96	.030	59	0.022	resolved

The three detected objects have luminosities of 10^{41} to 10^{42} ergs sec $^{-1}$, roughly comparable to the objects detected by Bahcall *et al.* (1984 ApJL, 284, L29) in their *Einstein* IPC observations of compact groups of galaxies. This flux is substantially less than the 4.4×10^{43} ergs sec $^{-1}$ found for NGC 2300 by Mulcahy *et al.* However we here report only the luminosities for the central source as found by standard software. It is possible that substantial extended emission, like that of NGC 2300, is present but not detected by us. Previously we had found a correlation between compactness of group and the presence of cold (neutral hydrogen) intergalactic gas. Although it is perhaps too early to say, we might be finding now that there is hot diffuse gas in the more extended groups, which helps remove the ISM from individual galaxies. In the more compact groups there is no gas left associated with individual galaxies, but it is all removed to the intergalactic medium (IGM) due to tidal interactions and ram pressure sweeping. Due to the much increased density of the IGM this gas has cooled and has become observable as a diffuse HI envelope in groups like HCG 31. It is our plan to publish the results after we have received and analyzed the data for all 10 groups. It is only then that we might draw some firm statistical conclusions concerning the evolution of compact groups.

2. The Fate of Gas in Merging Galaxies

As part of an ongoing study of the fate of gas in merging galaxies we have been granted ROSAT PSPC observations for 3 merger remnants. Till so far we have received and analyzed the observations NGC 7252, the Atoms for Peace galaxy. We have undertaken an investigation of the distribution and kinematics of the HI in NGC 7252, the H α and the light distribution and the X-ray emission, to help understand the encounter dynamics and to explore how this merger might go about ridding itself of its ample supply of cold gas. A total of 17381 s of PSPC time was acquired. X-ray emission was found in the central remnant body with a total luminosity of 2×10^{40} ergs s $^{-1}$. There is a hint that the X-ray emission might be extended. The implication is that in NGC 7252 all the neutral hydrogen gas is confined to the outer tidal regions, while all the molecular and warm and hot ionized gas is located within the central remnant body. Although the data are too

noisy to do a spectral fitting, the X-ray emission is consistent with that of a hot plasma. This hot gas can in several ways play an active role in removing neutral hydrogen from the remnant body and it thus formed a crucial link in our study of the fate of gas in NGC 7252.

The results of the X-ray observations of NGC 7252 were presented at the *American Astronomical Society* meeting in June 1993 and a comprehensive paper describing the fate of the cold, warm and hot gas in NGC 7252 has been submitted for publication to the *Astronomical Journal* (Hibbard, Guhathakurta, van Gorkom and Schweizer).